DOCUMENT RESUME

ED 258 827 SE 045 823

AUTHOR Eastman, Susan Tyler; Krendl, Kathy A.
TITLE Computers and Gender: Differential Effects of Electronic Search on Students' Achievement and Attitudes.
PUB DATE 84
NOTE 20p.; Paper presented at the Annual Meeting of the Communication, Language and Gender Conference (Oxford, OH, October, 1984).
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Academic Achievement; *Computer Oriented Programs; Computer Science Education; Educational Research; Grade 8; Information Retrieval; Junior High Schools; *Microcomputers; Science Education; *Sex Differences; Sex Stereotypes; *Student Attitudes

ABSTRACT

The effects of using a microcomputer for electronic research on the achievement and attitudes of eighth-grade boys and girls (N=247) were investigated. The study analyzed three dimensions of student themes, two sets of computer achievement measures, and three attitudinal dimensions for each of three treatment groups. Results showed no unpredicted differences by treatment group, but significant sex-related differences in theme writing and attitudes toward computers and sex roles. No differences in computer performance emerged in the computer group. Before the experimental treatment, girls held significantly fewer stereotypes and more positive attitudes toward their sex's potential computer abilities than boys, and the predicted reduction in the attitude gap between boys and girls that used computers emerged in the posttest. This study provides support for the generalizations that: (1) the computer task has greater influence on computer achievement than inherent verbal or spatial skills; and (2) experience using computers reduces sex-related stereotypes. It suggests that new technologies foster educational equity. (Author/JN)

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COMPUTERS AND GENDER:

DIFFERENTIAL EFFECTS OF ELECTRONIC SEARCH ON STUDENTS' ACHIEVEMENT AND ATTITUDES

by

Susan Tyler Eastman

and

Kathy A. Krendl

Department of Telecommunications
Indiana University
Bloomington, IN 47405
(812) 335-1700

Presented at the
Communication, Language and Gender Conference
Miami University, Oxford, Ohio
October 1984

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ABSTRACT

COMPUTERS AND GENDER:
DIFFERENTIAL EFFECTS OF ELECTRONIC SEARCH
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This experiment tested the effects of using a microcomputer for electronic search on eighth-grade boys' and girls' achievement and attitudes. The study analyzed three dimensions of student themes, two sets of computer achievement measures and three attitudinal dimensions for each of three treatment groups. Results showed no unpredicted differences by treatment group, but significant sex-related differences in theme writing and attitudes toward computers and gender roles. No differences in computer performance emerged in the computer group. Before the experimental treatment, girls held significantly fewer stereotypes and more positive attitudes toward their sex's potential computer abilities than boys, and the predicted reduction in the attitude gap between boys and girls that used computers emerged in the posttest. This study provides support for the generalizations that (1) the computer task has greater influence on computer achievement than inherent verbal or spatial skills, and (2) experience using computers reduces sex-related stereotypes. It suggests that new technologies foster educational equity.

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COMPUTERS AND GENDER: DIFFERENTIAL EFFECTS OF ELECTRONIC SEARCH ON STUDENTS' ACHIEVEMENTS AND ATTITUDES

By the start of 1984, over 200,000 microcomputers were being used in elementary, middle and high schools, and some schools were experimenting with videotex and other new technologies. Because educational equity is a social policy goal and index of program quality, introducing new media technologies in public schools raises the issue of their differential effects on female and male students. Steinkamp & Maehr (1984) tested effects sizes for published findings and confirmed that sex-related differences in school achievement and motivation favoring males appear. Sex-related differences in educational achievement have been explained on the assumption of (biologically or socially acquired) differences in abilities, cognitive style, possession of knowledge or identification with stereotyped sex roles (Shrock, 1979). The psychological literature has traditionally claimed that girls are better at verbal tasks while boys are better at spatial and abstract tasks (Haertel, 1978; Maier & Casselman, 1970). Sex-related differences in motivation have been explained by assuming a relationship between attitudes toward science and mathematics or self-concept (Handley & Morse, 1984). Although sex-related differences may apply to learning new technologies, few studies have directly examined gender differences in relation to communication media.

Maccoby and Jacklin (1974) reviewed the psychological literature on gender differences, Eakins and Eakins (1978) summarized gender differences in

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human communication, and Shrock (1979) assessed sex-related differences in relation to problem solving, but none reported studies relating gender to new technologies (including Lawton & Gerschner, 1982). However, a survey assessment of Minnesota computer students hypothesized that girls and boys may perform equally well on computers at the eighth-grade level (Anderson et al., 1982). Moreover, marketing studies have consistently reported demographic (sex, age) differences (Bolton, 1983; Dusay et al., 1983) especially in relation to adoption and usage of new technologies (Elton & Carey, 1982). Research into children's cognitive skills shows computer-related attitudes and abilities can be expected to vary between the sexes after about age six (Kirchner et al., 1983; Paisley, 1983; Williams & Williams, 1984). Recent educational applications of computers support this claim, typically asserting differences in achievement (operating skills) between females and males (Paisley & Chen, 1982; Rice, 1984; Williams & Williams, 1984). Based on these reports and studies, researchers could expect boys to outperform girls on computers.

However, these reports and studies have limited application to the current study for two reasons: age group and task studied. First, most computer research has focused on the primary grades rather than middle school ages (Paisley & Chen, 1982). But as of the mid-1980s, school curricula generally place the teaching of computer literacy and its application to other in-school activities (e.g., research, writing) at the middle/junior high school level (Eastman, 1984). Generalizing conclusions from primary level studies to early adolescents may exaggerate (or, conversely, minimize) gender differences related to developmental or social differences.

Second, the particular task may be the key indicator of achievement.

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In studies showing sex-related differences in motivational attitudes toward computers, girls have tended to be less desirous of learning to use computers than boys and less adept, at least initially (Corno & Mandinach, 1983; Lepper, 1982; Williams & Williams, 1984). Such studies, however, typically focused on learning computer programming or using a computer for arithmetic drill. Gender patterns in attitudes toward math and science (traditionally negative for girls) and toward libraries and writing (more positive for girls) may confound findings about computer performance if the kind of task influences computer learning (Anderson et al., 1982; Erickson & Erickson, 1984). It has been assumed that students associate the learning of computer skills with a talent for science and mathematics and hold stereotypical attitudes on girls' ability and interest in mathematics and computer operations (Deboer, 1984; Handley & Morse, 1984; Levin & Fowler, 1984; Scott, 1984; Steinkamp & Maehr, 1984). In general, girls have been shown to possess more negative attitudes toward science and math than boys (Fox, 1977; Kremer & Walberg, 1981) and toward computers in general (Williams & Williams, 1984; Winkle & Mathews, 1982). Extrapolating from research into sex-related attitudes and skills, then, researchers could expect boys to demonstrate greater motivation to learn to use computers and to master operating skills more rapidly and thoroughly than girls. However, no previous studies have examined gender differences in the context of learning to search electronic text. If girls perceive this task as similar to activities in which girls traditionally perform better than boys (e.g., library skills), then their attitudes may influence their computer achievement to the degree that they outperform boys.

In a third arena, the Johnson and Ettema (1982) research on the television series "Freestyle" showed that exposure to content challenging

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sexual stereotypes often tended to reduce the differences between boys' and girls' attitudes toward gender roles. Transferring this notion from television to computers leads to the following: If students hold contrasting attitudes toward computers aligned by sex, but side-by-side in-class use of computers gives little evidence of computer skill differences, students might feel their stereotypes about gender roles and computers challenged. In other words, experience with computers might alter sex-related attitudes toward computers. Further, if challenge reduces differences in gender-related attitudes, one circular (feedback) effect should be a reduction in any sex-related performance differences. Theoretical support for this position comes from the work of Salomon (1981) in positing reciprocal interactions between attitudes and experience, and applied support is suggested by Peterson, Burton and Baker (1983) who studies geometry success and concluded gender was not an influence. Based on the Johnson and Ettema research, we hypothesized that if a sufficiently strong challenge to students' stereotypes occurred, changes in self-report of attitudes should appear, in the direction of reducing the gap between boys' and girls' attitudes toward gender-related computer activities.

Hypotheses

To examine the questions left unanswered by the research to date, we analyzed sex-related differences in the context of using a microcomputer in a middle-school science class. We studied 26 eighth-graders (11 female, 15 male) while they used standard TRS-80 computers to access a commercial videotex system (CompuServe) containing an electronic encyclopedia (Academic American, a middle-school level encyclopedia commonly found in print in school

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libraries). This computer class was compared to another class of 31 students (17 female, 14 male) that used only print materials in the school library in the same assignment and to a control group of 23 students (10 female, 13 male) that did not do a research assignment at this time. Overall, these three eighth-grade science classes (80 students total) were 47.5 percent female, 52.5 percent male. (Sex distribution in the three science classes approximated the percentages in the entire eighth grade, N=247.) This study was a subset of a larger project assessing the feasibility of videotex as a learning tool for public schools (Eastman, 1984).

In order to look at students' accommodation of electronic text in a research and writing activity, the students' science theme assignment required them to learn to call up the videotex service (using an automatic dial modem) in order to search the electronic encyclopedia. While the other 18 students looked at their computer printouts or used the usual print media in the school library, nine students at a time conducted a computer electronic search for information on their chosen topics. They had instructional workbooks and were supervised by one or two teachers and two participant-observers. After two weeks of rotating computer search, the class returned to their regular classroom for theme writing.

Because using a computer to access an electronic encyclopedia may elicit motivations more like those generated by library work than computer programming, this study asked if this project might be a special case of computer use, not supporting the findings of other computer research. Students may perceive searching an electronic encyclopedia as more related to libraries and writing (largely verbal) than to working with mathematics or machines (spatial). If so, girls should exhibit positive attitudes toward

computers when using them to access electronic text and demonstrate operating skills equivalent or superior to boys' (at middle-school level). In other words, this study contributes to the literature investigating whether the task or the medium primarily influences outcome.

On the assumption that the students would perceive this assignment to be more like library and writing activities than typical computer activities (i.e., computer programming or math), these researchers hypothesized that (1) girls would perform better on the final product of the assignment, the theme, than boys, irrespective of treatment group (electronic or print classes). Further, it was hypothesized that (2) girls would demonstrate higher levels of achievement (operational skills) on the computers than boys in this project. In the event that students initially reported sex-related differences in attitudes toward computers, it was hypothesized that (3) the difference in attitudes between the sexes would diminish after their computer learning experience (i.e., the gap would get smaller).

Method

While the students used the computers, the electronic material they accessed was stored on disks and later printed out to provide hard copies for the students. Copies of these data provided an unobtrusive daily record of what each student did on a computer. After their computer search ended, the research team administered brief competency tests on the TRS-80s, assessing each student's ability to manipulate the computer and find specific information carried by the videotex service. These data provided a comparison of computer achievement by gender. A month prior to the computer project, the

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entire eighth grade (247 students) completed a lengthy attitudinal questionnaire, including items related to attitudes toward computers and gender roles as well as library use. Two weeks following the project, a posttest covering the same items was also administered by the classroom teacher. When the computer and print students' science themes were turned in, blind copies were evaluated by a team of four eighth-grade science teachers. We could then compare their themes by gender within and between the two classes (treatment groups). This study's goal was to compare multiple measures and dimensions of achievement and attitude to determine the relationship of gender to learning to use a computer for research. We analyzed three groups of measures: achievement on themes, achievement on computers and attitudes toward computers.

To assess achievement on themes, we compared evaluations of the themes from the print-only and electronic classes. Three dimensions were examined--quality of organization (logical structure), physical appearance (neatness) and referencing ability (number and quality of bibliographic entries). Four judges evaluated each dimension on a scale of 1-3. Analysis of variance was used to compare mean scores by treatment group and gender.

To assess achievement on computers, seven measures were examined. We compared the results of the computer competency tests using three competence measures--the ability to log on, open the computer's buffer memory and use a specific express command (GO AAE-xxx). Two of these measures relate to computer and videotex operation, one to electronic text manipulation. In addition, we examined the unobtrusive records of the students' computer operations (copies of their disk records), comparing girls and boys on four dimensions: numbers of operations performed, successful keyword searches,

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errors in search procedures and total pages of information accessed. Chi square and t-tests were used to compare computer performance by gender.

To assess attitudes before and after computer use, we evaluated responses on the pretest and posttest to 22 items. Students were asked to specify degrees of disagreeing or agreeing with 11 statements about computers and self, 7 items on libraries and self and 4 items on computers and gender roles. After factor analysis using oblique rotation confirmed the three dimensions, individual items within each factor were then summed to create three attitude indices. A posttest of the same items provided self-reports on the three groups' attitudes toward computers and self, libraries and computers and gender roles after the experimental treatment (the electronic and print searches). We were then able to test for differences between before and after attitudes on each item for the 26 computer, 31 print-only and 23 control students attributable to gender, controlling for the effects of treatment and initial attitudes. Using the posttest summed indices as dependent measures, we employed multiple analysis of variance with pretest scores as covariates.

Results

Comparison of pretest results for the three experimental groups with those for all 247 eighth graders showed no significant differences, providing the grounds for generalization from our sample to the rest of the school's eighth-grade students. The school itself is one of only two middle schools in the community and draws largely from blue collar families. The results in this section are divided to correspond to the two achievement and one attitudinal hypotheses.

Achievement on Themes:

Two-way analysis of variance of mean differences for girls and boys on the three dimensions of the theme evaluations showed main effects for gender without treatment interaction, as predicted. Girls showed significantly higher scores for organization ($F=7.05$, $p<.01$), presentation ($F=5.90$, $p<.01$) and referencing ability ($F=3.92$, $p<.05$) that cut across both the print and electronic groups. These are the types of differences that might be expected based on girls' preferences for library and verbal skills.

Achievement on Computers:

Results from comparison of the computer achievement measures showed little difference between girls' and boys' performance on any of the seven measures (competence tests or operations performed). Boys and girls were equivalent in the ability to log on (75%, 73%) and open buffers (81%, 73%), while boys were somewhat more successful than girls at using an express command without help (63%, 45%; for Chi squares, $p<.00$). T-tests comparing computer operations from the disk records showed no significant difference on any of the four measures-- total number of operations performed, number of successful searches, quantity of errors or total pages accessed ($p>.05$). Together, the hands-on test and operational records gave no support to our second hypothesis that girls would outperform the boys, although it showed the girls performing no worse than the boys.

Attitudinal Changes:

First, we looked at the pretest. Analysis of variance of the three indices based on the 22 Likert-scale items relating to computer and self, libraries and computers and gender showed no significant differences among treatment groups on the pretest, establishing the equivalence of the three classes on the initial attitude scales. (All three classes had equivalent percentages of females and males, and none of the computer class students had prior computer experience.) We could then compare responses by gender across all three groups on the pretest.

Comparison of pretest means by gender for the 80 students on the three indices showed no significant differences in attitudes toward computers and self ($F=1.97$, $p>.05$) and attitudes toward libraries ($F=3.19$, $p>.05$), but did show significant differences for attitudes toward computers and gender-roles ($F=6.68$, $p<.01$). On the computers and gender roles, boys held more stereotypical views than girls ($F=6.10$, $p<.05$). For example, girls were less likely to expect that their abilities would differ from boys ("girls in general," "girls at this school"), and girls were less likely to think that math skills were related to learning to use computers. This pattern was also evident within the computer class; girls and boys differed like the 80 students overall on their attitudes toward computers and gender roles ($F=8.67$, $p<.01$) on the pretest.

Insert Table 1 about here

Second, to look at attitude change, we looked at the posttest. We

compared all three groups' posttest responses on the three indices using analysis of variance with gender and treatment group as predictor variables and the pretest scores as covariates. Results showed no main effects for gender on the three indices, but did show a main effect for treatment on the index of attitudes toward computers and self. This suggests that the computer group overall was significantly different in attitude after using a computer (i.e., that, predictably, using a computer did make a difference in perceived competency). However, analysis of variance of the computer group alone showed no significant difference between males and females on this index. It was solely a treatment effect.

Of greater interest was the pattern of response on the pretest and posttest on the index computers and gender-roles. A significant sex-related difference occurred on the pretest and disappeared on the posttest. Table 1 presents the group means and F-scores for the attitude indices for both the pretest and posttest. For the posttest, it shows a non-significant F-score of 3.09 ($p>.05$) for computers and gender roles.

Discussion

In conclusion, then, this analysis shows writing tasks dominating over the new technology aspects of the students' science assignment. Girls consistently performed better than boys on their themes on traditional verbal dimensions in both the computer and print-only classes. Differences in computer performance also failed to appear; boys and girls in the computer group showed equivalent operational skills. These results support the first hypothesis that girls would perform better on the writing portion of the

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assignment and supply some indirect support for the proposed theoretical perspective on computer learning. It suggests that these students perceived the task of research electronic text as more like researching print materials than like computer programming or mathematics drill--despite the fact that they (a) had to learn to operate a computer and videotex without prior experience and (b) had to learn to manipulate an electronic encyclopedia to achieve a text printout that met their research needs in a very short time. This is evidence then that student achievement on computers may be more related to the kind of activity than to any inherent sex-related abilities.

Although our second hypothesis, that the girls would outperform the boys in computer skills, was not supported by our analysis of the competency tests or the records of computer operations, the results show that the girls were not significantly behind the boys in skill. The finding of gender equivalence under conditions of first exposure is of interest--although it is, like most case studies, based on a small sample of students. However, it gives support to research showing gender equivalence in achievement among middle-school students and suggests instructional activities that may encourage gender equity.

Attitude measures initially showed boys generally holding more stereotypical attitudes toward computer technology and sex roles than girls, whereas girls appeared less ready to accept differences between the sexes or stereotypes relating to computer skills. These findings support the first condition of hypothesis three predicting sex-related different initial attitudes toward computer technology. In the pretest, the index for gender-role items showed significant differences between boys and girls overall, as well as for the computer only group.

However, comparison of the posttest indices for all students and for the computer group alone showed no sex-related differences in computer and gender-role attitudes, indicating that whatever initial gender gap existed had disappeared. Both boys and girls changed in the direction of a more equitable assessment of computers and gender roles after computer use--implying that both sexes can work well with computers, but not everyone does, regardless of gender. Thus, the posttest results showed a reduction in the differences between the sexes supporting the Johnson and Ettema television-based conclusion of gender gap reduction (and hypothesis three). Experience with computers (at least for electronic search) tended to reduce stereotypical views on computers and gender.

In sum, this study provides suggestive lines of attack for research in new technologies. It contradicts generalizations based on primary-age children and projections from math and science attitudes to computer attitudes, suggesting instead that the specific computer activity may be a key variable in measuring gender and other differences in achievement and attitude. This study contradicts studies showing girls' lesser motivation and achievement and, instead, gives support to the idea of equal achievement on computers. Our results, based on unobtrusive measures of computer operations and knowledge, provide the clearest support for gender equivalence in using a computer. In addition, the attitudinal measures show female students with more positive images of themselves in relation to new technology than some previous research indicated. These results suggest that computers may foster the goals of social and educational equity.

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Table 1.--Pretest and Posttest Group Means for Three Attitude Indices
N=80

Indices and items	Group Means			
	Pretest		Posttest	
	Boys	Girls	Boys	Girls
Computers and Self:	34.33	33.18	33.36	32.84
	F=1.96		F=.00	
I would like to learn more about computers.				
I feel confident about my ability to use computers.				
It is my guess that I am NOT the kind of person who works well with computers.				
Learning about computers makes me feel uneasy or uncomfortable.				
I am not that interested in computers because computer people are boring.				
It would be difficult for me to learn to use a computer.				
Being able to use a computer would give me a sense of accomplishment.				
Computers can be fun to learn about.				
If I were good at computers, my friends would respect me.				
Compared with other students my age, I am better with computers.				
Compared with other students my age, I am more interested in computers.				
Libraries and Self:	20.07	18.92	20.33	19.58
	F=3.19		F=.17	
I enjoy going to libraries.				
I understand how to use the library to search for something.				
I go to the library only when I have to for school assignments.				
Most material in the library isn't really useful to me personally.				
It is hard to find what you need in the library.				
When I go into a library and see all the books, I feel bored.				
Libraries make me feel uneasy because I don't really know how to use them.				
Computers and Gender:				
All subjects (N=80)	12.90*	12.03*	8.38	7.92
	F=6.58**		F=3.09	
Computer Group only (N=26)	13.00**	11.91**	7.47	7.82
	F=8.67**		F=.25	
Learning about computers is just as important for women as for men.				
Every middle school student should have some understanding of computers.				
Boys are better than girls at working with computers.				
The boys in my school are better with computers than the girls.				

Scales: 1=Strongly disagree, 2=disagree, 3=undecided, 4=agree, 5=strongly agree

*p<.05

**p<.01